

Quantifying Role of Seaweed (*Caulerpa racemosa*) Harvesting in Livelihood System of Some Coastal Communities in Fiji

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Abstract

The relative combinations of various work activities in the rural livelihood systems are not well understood. This study investigates roles of various work activities in the household income and employment in coastal areas of Fiji. Data were obtained by personal interview method from a random sample survey 48 households from four coastal villages in Fiji. Study revealed that workers in the coastal areas have work opportunities for only 20 h per week against a 40 h work norm. About 76% of their total work time was devoted to sea-based resources (58% for seaweed harvesting and 18% for fishing). Coconut collection and handicraft activities accounted for 17 and 7 percent of their work time, respectively. Overall, average weekly income of workers was about FJ\$110. The share of income from seaweeds was about 50% and the shares of income from fishing, coconut activities and handicrafts were 21.9, 20.5 and 8 percent, respectively. Hence, it is clear that although seaweed harvesting activity in the overall economy of Fiji is still at the subsistence level, but this activity plays a very critical and substantial role in the food and nutrition security of the coastal communities.

Keywords: Seaweed harvesting, Income from seaweeds, Women in seaweed harvesting

1. Introduction

Fiji is a nation of some 300 islands having a total land area of 18,333 km² with a population of 881,100 persons. About half of population lives in rural areas depending on primary products from land and sea for their living (FIBOS, 2010). Majority of farmers in Fiji (56.2%) are smallholders operating less than 2 hectares land (Fiji, 2009). Smallholder farmers in coastal areas supplement their earnings from nearby sea resources. Fishing and seaweed harvesting are important sources of livelihoods and nourishment to coastal communities (Abbott, 1988; Borowitzka *et al.*, 2009). Tropical seaweeds have long been utilized by man as food, medicines, as ceremonial objects and for ornaments (Masuya, 2011; Valderrama *et al.*, 2013).

Seaweed is the common name for marine algae that grow in ocean (Guiry and Guiry, 2011; Littler and Littler, 1988; Mourtisen, 2013). Seaweeds are autotrophic, photosynthetic plants and they are a significant feature of most shorelines and shallow water environments throughout the world normally growing attached to the substratum in marine benthic habitats, and having a plant body readily visible to the naked eye (Mourtisen, 2013; South, 1993a & b; Wright and Hill, 1993). The most abundant populations of seaweeds occur on hard substrata such as rock and corals, as well as man-made structures, and on the breathing roots of mangroves (Guiry and Guiry, 2011; Lewis *et al.*, 1988; Mourtisen, 2013; Pickering and Mario, 1999). South

Pacific tropical island region has extensive coral reefs and lagoons characterized by slow to moderate currents, clear water, and sandy or coralline bottoms, these provide ideal habitats for seaweed (Littler and Littler, 1988; Ram, 1991).

Morris *et al.* (2014) report that throughout the Pacific region human consumption of seaweed is widespread, although only few detailed statistics are available on the quantities harvested or the contribution that it makes to household incomes at the village level. Also, the potential of generating employment and income from aquaculture activities such as seaweed harvesting is not well documented in the South Pacific region. Keeping in view this research gap, a study was undertaken in Fiji to investigate following aspects about seaweed harvesting: (a) How many workers of family are engaged in seaweed harvesting in coastal villages? (b) How much time of their work schedule workers devote to seaweed harvesting? (c) How much quantity of seaweed is harvested by workers per week? (d) How much income is generated by workers from seaweed harvesting? (e) What is the proportion of seaweed income in the overall income of the workers in coastal villages? The findings of this study in Fiji are presented in this paper.

2. Methodology

2.1. Location of study area

Bala and Morris (2011) reported that major part of seaweed (*Caulerpa racemosa*) supply in major municipal markets of Fiji (i.e., Lautoka, Nadi, Sigatoka and Suva) comes from the Yasawa group of islands and from Vatuloa area. Thus this region was chosen for the field survey in Fiji Islands. From the study area a sample of four villages (i.e. Somosomo, Gunu, Nasoqo and Vatutavui) was drawn for field work: From sample villages a sample of 46 households was selected randomly. From the sample families all their seaweed harvesters (68 in number) were interviewed for obtaining required data.

2.2. Data Collection and Analysis

The data were obtained from each of the seaweed harvesters in the sample families by face-to-face interview method on a structured questionnaire. Interviews were conducted during the months of June and July 2013. Interview of each respondent lasted about 30 min. Respondents were asked questions about their age, education, years of experience in seaweed harvesting, weekly h devoted to seaweed harvesting each day/week and other economic activities performed by them, number of times seaweed harvested in a day, quantity of seaweed harvested daily and weekly, income generated from seaweed harvesting and outputs and income from other work activities performed.

Data were analysed to obtain averages for the time devoted in seaweed harvesting, quantity of seaweed harvested and income generated, share of seaweed income in the total income of the worker from various productive activities, and so forth. Also, to understand the factors which have impact on the quantity of seaweed harvested by worker, a linear regression model of the following type was fitted to the data:

$$Q = a + b_1 A + b_2 E + b_3 W + b_4 H + e$$

Where, Q = the quantity of seaweed harvested (kg per week) by a worker; H = Hours spent by worker on seaweed harvesting in a week; A = Age of the seaweed harvester (years); E = Education of the seaweed harvester; W = Number of workers in family engaged in seaweed harvesting; and e = random error. The a's and b's in the equation denote respective regression coefficients.

3. Results

The results of the data analysis are organized in five sub-heads: (a) number and proportion of workers performing various combinations of work activities; (b) proportional time devoted to seaweed harvesting; (c) quantity of seaweed harvested by workers; (d) income

earned from seaweed harvesting; and (e) share of seaweed income in the total income earned by the worker.

3.1. Number of Workers in Different Combinations of Work Activities

Workers in the coastal areas gather seaweed from the common open-access sea near their villages. Seaweed harvesters perform various other activities in addition to seaweed harvesting. Data in Table 1 shows the numbers and proportions of seaweed harvesters pursuing various combinations of income earning activities. It can be seen in Table 1 that about 25 percent of workers were engaged in seaweed harvesting work only. Work combining seaweed harvesting and coconut activity was performed by 23.5 percent workers. About eighteen percent of total workers were engaged in seaweed harvesting and fishing activities. The combination of seaweed harvesting plus coconut and fishing activities was pursued by about 10 percent workers. About 7 percent of seaweed harvesters were also engaged in making handicraft products. Hence, the data analysis shows that workers in coastal villages perform multiple activities to remain gainfully employed to sustain their families.

3.2. Proportionate Time Devoted to Seaweed Harvesting

Seaweed harvesters perform various productive activities. The time devoted to different income earning activities pursued by seaweed harvesters is shown in Table 2. Data analysis revealed that on the whole workers do not have enough work as on average they worked on different income earning activities for about 20 h per week. About 12 h time (i.e. 58 percent of total work time) of workers was devoted to seaweed harvesting per week. Fishing and coconut activities accounted for about 18 and 17 percent time of workers respectively. About 7 percent of working time was devoted to making of handicraft products. Relatively female workers devoted more proportion of their time (about 60 percent) for seaweed harvesting as compared to male workers, who had devoted about 48 percent of their total working time for seaweed harvesting activities.

3.3. Quantity of Seaweed Harvested by Workers

Quantities of seaweed harvested by workers were estimated for different categories of workers pursuing different combinations of income earning activities. The results are presented in Table 3. Overall, on an average 30.8 kg of seaweed was harvested by a worker per week. On average about 33.6 kg of seaweed was harvested per week by the workers who pursued seaweed harvesting activity only. The quantity of seaweed collected by those workers who had

combination of fishing and seaweed harvesting activities was 32.9 kg per week. Average amount of 30.7 kg seaweed was harvested by workers who performed combination of seaweed and coconut collection activities. As regards gender wise comparison of seaweed collection, on average male worker harvested 27.3 kg seaweed while the female worker harvested 32.8 kg seaweed per week.

The quantity (kg/week) of seaweed harvested by each worker was regressed against the age and educational level of worker, the time (hours) spent by worker on seaweed harvesting, and the number of harvesters (workers) in the family. The estimated linear regression equation is as follows:

$$Qty = 9.615 + 0.005 Age - 0.654 Edu + 1.951*Hour + 0.007 Workers$$

(4.138) (0.102) (1.338) (0.251) (0.775)

Figures in parentheses denote standard errors of the respective regression coefficients.

$$R^2 = 0.75 \text{ and } n = 68.$$

*Denotes statistical significance at 5% level.

The regression analysis indicated that the quantity of seaweed harvested by a worker is positively and significantly affected by the number of hours spent by the worker on seaweed harvesting. The personal characteristics of the workers (i.e. age and education) had insignificant impact on the quantity of seaweed harvested by the worker.

3.4. Contribution of Seaweed Income to the Total Income of Workers.

Seaweed harvesters' average weekly earnings from different work activities are shown in Table 4. Overall average weekly earnings of workers was FJ\$109.87.

Income from seaweed harvesting was FJ\$54.65 per week, which accounted for 49.7 percent share in the total income earned by workers in a week. Income earned from fishing and coconut activities respectively contributed for 21.9 and 20.5 percent shares in the total income of workers. About eight percent proportion of total income of the workers was earned from making handicraft products. On average male seaweed harvesters earned FJ\$446.92 and female harvesters earned FJ\$56.48 per week from the seaweed harvesting activity, which comprised 40.0 and 52.2 percent of their respective total incomes per week.

Table 1. Number and proportion of workers performing various combinations of work activities.

Combinations of activities performed	Male workers	Female workers	All workers
Seaweed harvesting only	1 (7.7)*	16 (29.1)	17 (25.0)
Seaweed + coconut activities	4 (30.8)	12 (21.8)	16 (23.5)
Seaweed + fishing activities	1 (7.7)	11 (20.0)	12 (17.6)
Seaweed + coconut + fishing activities	4 (30.8)	3 (5.5)	7 (10.3)
Seaweed + coconut + handicraft activities	2 (15.3)	7 (12.7)	9 (13.2)
Seaweed + fishing + handicraft activities	1 (7.7)	6 (10.9)	7 (10.4)
Total	13 (100)	55 (100)	68 (100)

*Figures in parentheses denote percentages to the respective total

Table 2. Seaweed harvesters' allocation of time to various income earning activities (Hours/worker/week).

Activity	Male workers		Female workers		Overall	
	Hours	%	Hours	%	Hours	%
Seaweed harvesting	10.0	47.6	12.2	60.4	11.8	57.8
Fishing activity	5.0	23.8	3.4	16.8	3.7	18.1
Coconut activity	5.1	24.3	3.0	14.9	3.4	16.7
Handicraft activity	0.9	4.3	1.6	7.9	1.5	7.4
Total	21.0	100	20.2	100	20.4	100

Table 3. Average quantity of seaweed harvested by workers (kg/worker/week).

Category of worker	Males	Females	All workers
Seaweed harvesting activity only	33.2	36.1	33.6
Seaweed + fishing activities	30.0	33.2	32.9
Seaweed + coconut activities	27.0	31.8	30.7
Seaweed + coconut + fishing activities	27.4	27.7	27.5
Seaweed + coconut + handicraft activities	20.8	30.8	28.6
Seaweed + fishing + handicraft activities	32.3	30.0	30.3
Overall	27.3	32.8	30.8

Table 4. Share of seaweed income in the total income of seaweed harvesters (per week per worker).

Activity	Male workers		Female workers		All workers	
	Income FJ\$	%	Income FJ\$	%	Income FJ\$	%
Seaweed harvesting	46.92	40.0	56.48	52.2	54.65	49.7
Fishing activity	35.38	30.2	21.31	19.7	24.00	21.9
Coconut activity	30.00	25.6	20.73	19.2	22.50	20.5
Handicraft activity	4.94	4.2	9.62	8.9	8.72	7.9
Total	117.24	100.0	108.14	100.0	109.87	100.0

4. Discussion

Seaweeds are a significant feature of most shorelines and shallow water environments growing attached to the hard substrata such as rock and corals and on the breathing roots of mangroves (Guirry and Guirry, 2011; Lewis *et al.*, 1988; Mourtisen, 2013; South, 1993a & b; Wright and Hill, 1993). In the South Pacific tropical island region which has extensive coral reefs and lagoons there are abundant natural populations of seaweeds (Littler and Littler, 1988; Ram, 1991). In coastal communities seaweed harvesting and fishing on the reef flats or near the reef edge in seashore areas next to their villages is a common activity of farming families.

Data analysis revealed that the majority of seaweed harvesters in the study area were female workers. As women workers are less educated and lack other skills, they get fewer opportunities to carry out other high remunerative activities outside their villages and thus were engaged in self-employment activities of the family. Since no single work activity alone provided them with sufficient income opportunities, workers were engaged in multiple tasks to meet their livelihood needs. In addition to seaweed harvesting, workers in coastal areas collected coconut from their fields, participated in fishing activity and made handicraft products. About one-quarter of total workers were engaged in seaweed harvesting activity only, while the three-fourth proportion of workers performed combinations of various other income generating activities. Seaweed harvesting with fishing and seaweed harvesting plus coconut collection were two most

popular combinations of work activities in the study area.

On average a worker had opportunity for productive work for about 20 h per week against the general normal employment norm of 40 h work per week. In the total 20 h work duration the percent shares of seaweed harvesting, fishing, coconut and handicraft activities were 58, 18, 17 and 7 percent, respectively. Clearly, the seaweed harvesting was an important source of employment for the workers.

On average about 31 kg seaweed was harvested by a worker per week. The regression analysis revealed that the quantity of seaweed harvested (kg/week) by a worker was positively and significantly related to the number of hours spent by the workers on the seaweed harvesting. The other factors such as experience or educational level of the worker had negligible impact on their output performance. Perhaps this may be due to the fact that seaweed harvesting being a simple task requiring no special skills or experience to enhance productivity of worker was performed equally well by all workers of different ages and educational level.

From different sources weekly average earning of workers was about FJ\$110. The contribution of seaweeds in the total income of worker was almost 50 percent. Shares of incomes generated from fishing and coconut activities in the total income of workers were about 22 and 21 percent respectively. The contribution of income earned from the sale of handicraft products made by workers was about eight percent in the total

income generated by workers. On average a male worker earned FJ\$117 per week and female worker earned FJ\$108 per week. Contribution of seaweeds was worth FJ\$47 in male worker's weekly income and worth FJ\$56 in the female worker's weekly earnings, these contributions accounted for about 40 and 52 percent shares in their respective total incomes.

5. Conclusion

Both land and sea resources are used by coastal village people for their sustenance. Harvesting of wild seaweed from the public open-access sea resource is an important activity of the coastal communities. It is the major source of employment and income generation for rural workers. Keeping in view the time devoted and quantity harvested it may be concluded that seaweed harvesting in Fiji is mostly at the subsistence level, where the income derived from it supplements fishing, farming and other activities but it is a critical activity in sustaining rural livelihood system of coastal communities. However, the seaweed harvesting, which is dominated by women workers, has empowered the rural women by making them economically more active members of the family. Finally, integrated planning of land and sea-based activities is essential for increasing resilience and sustainability of livelihood systems of rural coastal communities.

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